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By-Rahmlow, Harold F.; And Others

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This programed mathematics textbook is for student use in vocational education courses. It was developed as part of a programed series covering 21 mathematical competencies which were identified by university researchers through task analysis of several occupational clusters. The development of a sequential content structure was also based on these mathematics competencies. After completion of this program the student should be able to correctly use = and not = signs, symbols representing division such as a/b, and symbols representing multiplication as a x b, a . b, ab, a(b), and (a)(b). The material is to be used by individual students under teacher supervision. Twenty-six other programed texts and an introductory volume are available as VT 006 882-VT 006 909, and VT 006 975. (EM)

FINAL REPORT
Project No. OE7-0031
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Report No. 16-A

Occupational Mathematics

SYMBOLS

June 1968

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Occupational Mathematics

SYMBOLS

Project No. 0E7-0031
Contract No. OEG-4-7-070031-1626
Report No. 16-A

by
Harold F. Rahmlow
Karl Ostheller
Clarence Potratz
Leonard T. Winchell
Arthur Snoey

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Washington State University, Department of Education, Pullman, Washington
State Coordinating Council for Occupational Education, Olympia, Washington

OBJECTIVES

1. The student should be able to correctly use = and $\neq$ signs.

2. The student should be able to correctly use the following symbols which denote division:

   $\frac{a}{b}$, a/b, and a ÷ b.

3. The student should be able to correctly use the following symbols which denote multiplication:

   a x b, a · b, ab, a(b), (a)(b).

Greetings! You are about to begin improving your knowledge of basic mathematics. There are many important uses for the mathematics you are learning.

This booklet is not like your ordinary books. It is designed to help you learn as an individual. On the following pages you will find some information about mathematics. After the information is presented, you will be asked a question. Your answers to these questions will determine how you proceed through this booklet. When you have selected your answer to the question, turn to the page you are told to.

Do not write in this booklet. You may wish to have a pencil and some paper handy so you can write when you want to.

Remember this is not an ordinary book.

1. Study the material on the page.
2. Read the question on the page (you may want to restudy the material on the page).
3. Select the answer you believe is correct.
4. Turn to the page indicated by your answer.

Are you ready to begin?

(a) Yes — Turn to page 1

(b) No — Turn to page C

(c) HELP — Go see your teacher

Your answer was (b) No.

Well, this booklet is a little different.

Go back and read page B again. After you have read it, you will probably be ready to begin.

In this unit we will discuss some of the most commonly used symbols in mathematics. This may be a quick review for you, or you may learn some new symbols.

As you know, we use many symbols in mathematics. In fact, a number like 5 written on this paper really symbolizes the idea of "fiveness." These symbols are used to shorten our work.

There are two symbols which you have been using since grade school. You should be familiar with these by now. They are the "+" symbol which signifies addition and the "-" symbol which signifies subtraction.

There is another symbol which you have probably been using for a long time. That is the "equal" sign. It is written "=." This symbol means that the quantities shown have the same value. Here's a problem to get you started:

Does 2 + 1 = 3?

(a) Yes — Turn to page 6

(b) No — Turn to page 10

Ooops. I thought you had it.

What is 19 - 8? It is 11. So we can say 19 - 8 = 11, since the "=" means both sides have the same value.

Okay, try this one.

Does 7 = 7?

(a) Yes Turn to page 11

(b) No Turn to page 9

Incorrect.

The best way to work a problem like the last one is to simplify both sides into one number if you can. Then it becomes much easier to compare them.

Which of the following is a <u>true</u> statement?

(a) $15 = 11 + 4$ Turn to page 7

(b) $15 \neq 11 + 4$ Turn to page 13

Good! You used the "≠" sign correctly.

Now, look at this statement:

$$8 - 5 \neq 10 - 7$$

The statement is:

(a) True — Turn to page 3

(b) False — Turn to page 20

No, you still don't see it.

Is 4 the same as 5? Of course not. But, if you write 4 = 5, you are saying that they are the same. You know this is a false statement.

The "=" sign between any two quantities <u>always</u> means their values are the same.

Now, does 2 = 2?

(a) Yes Turn to page 11

(b) No Turn to page 9

Good! Your answer was correct.

You are probably aware of how important it is in mathematics to be able to say that two quantities are equal by using the symbol "=." It is also important to be able to say when two quantities are <u>not</u> equal. The symbol "$\neq$" means that the quantities shown are <u>not</u> equal to each other.

Try this problem.

Which of the following is a <u>true</u> statement?

(a) $8 - 3 = 4$ Turn to page 8

(b) $8 - 3 \neq 4$ Turn to page 20

Good!

Now, how do you write 9 is not equal to 7?

(a) $9 = 7$ Turn to page 9

(b) $9 \neq 7$ Turn to page 4

You said 8 - 3 = 4. Are you sure you understand what you said?

You said that 8 - 3 has the same value as 4. But 8 - 3 is 5. Is 5 the same as 4? No, it isn't. So we can say $5 \neq 4$ or $8 - 3 \neq 4$.

Now, which of these statements is correct?

(a) $3 = 2$ Turn to page 13

(b) $3 \neq 2$ Turn to page 4

Sorry, you're just not getting it.

I think your teacher can help you understand the equal sign. Ask your teacher for help. Then return to page 1 of this booklet.

Incorrect.

When you add 2 and 1, you get 3. So 2 + 1 = 3.
This means that 2 + 1 and 3 are the same quantity.
The "=" sign always indicates that the quantity
on the left side has the same value as the quantity
on the right side.

O.K. Let's try again.

Does 4 = 5?

(a) Yes Turn to page 5

(b) No Turn to page 11

Very good! Your answer was correct.

Does 19 - 8 = 11?

(a) Yes — Turn to page 6

(b) No — Turn to page 2

Correct this time! Maybe you have it now.

Go on to page 6 and continue from there.

No. Remember the "=" means the two quantities expressed have the same value, while "≠" means the two quantities have different values.

The statement $6 \neq 8$ is:

(a) True — Turn to page 12

(b) False — Turn to page 9

Ooops. You forgot the rule.

The denominator of the fraction is always the number you are dividing by.

What does S ÷ R mean?

(a) S divided by R Turn to page 26

(b) R divided by S Turn to page 23

(c) S multiplied by R Turn to page 24

Excellent! Your answer was correct.

Now look at the following statement:

$7/4 = 7 \div 4$.

This statement is:

(a) True — Turn to page 21

(b) False — Turn to page 25

All right. Let's see if you understand what you just read.

How would you write 3 divided by 2?

(a) $\frac{3}{2}$ Turn to page 21

(b) 2/3 Turn to page 22

Hold it just a minute!

You know that p = q means p is equal to q, but that wasn't the problem.

Go back to page 26 and try again.

Sorry, wrong answer.

I don't think you're trying hard enough. It's really not so hard.

Go to page 20 and read the material carefully.

Then continue from there.

Turn to page 20.

Now try this problem.

Does $\frac{a}{b} = a \div b$?

(a) Yes Turn to page 15

(b) No Turn to page 25

Very good! Keep the "=" and "≠" sign firmly in mind. They will appear frequently.

The next area we will consider is that of division. There are three main symbols that are commonly used to indicate division. These are "-," "/," and "÷." For example, $\frac{1}{2}$, 1/2, and 1 ÷ 2 all mean the same thing. They mean 1 divided by 2. All three examples can be read this way. Note that the number you are dividing by is on the bottom in the first two examples and on the right in the third.

Turn to page 16

Fine! Your last answer was correct.

What does x/y mean?

(a) y divided by x Turn to page 14

(b) x divided by y Turn to page 33

No. Wrong choice.

The proper location of the numbers you are working with is one of the most important ideas you must master.

The key in division is "divided by." The number you are dividing by <u>always</u> appears in the denominator of the fraction. (The denominator is the bottom number, remember?)

If the "÷" symbol is being used, the number you are dividing by always <u>follows</u> the symbol.

Do you understand the material on this page? When you do, turn to page 19.

No. You did it upside down again.

Let's look at a few more examples:

4/9 means 4 divided by 9

$\frac{a}{b}$ means a divided by b

7 ÷ 6 means 7 divided by 6

Do you see how it works?

Try this problem.

Are $\frac{3}{4}$ and 3/4 the same?

(a) Yes Turn to page 26

(b) No Turn to page 25

What? No, ÷ does not mean multiply. NEVER.

See if you can make a better selection.

Turn to page 14.

Incorrect. The two fractions were the same.

See if you can get this one.

M divided by N means:

(a) $\frac{N}{M}$ Turn to page 18

(b) $\frac{M}{N}$ Turn to page 15

Very good!

See if you can get back on the path with this one.

How would you write "p divided by q"?

(a) q/p Turn to page 23

(b) $p = q$ Turn to page 17

(c) $\frac{p}{q}$ Turn to page 33

No. You got the divisor and the dividend switched around again.

See if you can get back on the right track with this one.

Does $\frac{4}{3} = 3 \div 4$?

(a) Yes Turn to page 39

(b) No Turn to page 36

Hold on there! I think you were a little careless on that one.

Both M ÷ K and M/K are correct ways of writing M divided by K.

Let's continue.

Does $2/3 = \frac{3}{2}$?

(a) Yes Turn to page 34

(b) No Turn to page 31

Fine! You're doing well.

Which of the following ways of expressing I divided by K is <u>incorrect</u>?

(a) I ÷ K Turn to page 28

(b) I/K Turn to page 35

(c) Neither is incorrect Turn to page 44

No.

Don't forget what "÷" means. Literally, it means "divided by." It has exactly the same meaning as the "/" and the "-."

The correct answer to the last problem was that 12 divided by 4 can be written as 12 ÷ 4.

Turn to page 32.

O.K! That's more like it!!

Which of the following is an <u>incorrect</u> way of expressing K divided by 5?

(a)	K/5	Turn to page 41
(b)	5 ÷ K	Turn to page 44
(c)	$\frac{K}{5}$	Turn to page 27

The expression $b \div c$ is the same as:

(a)	b/c	Turn to page 36
(b)	bc	Turn to page 40
(c)	$\frac{c}{b}$	Turn to page 27

Excellent! Keep up the good work.

How would you use the "÷" symbol to write 12 divided by 4?

(a) $4 \div 12$ Turn to page 30

(b) $12 \div 4$ Turn to page 29

(c) $12 \cdot 4$ Turn to page 37

No. 2/3 does not equal $\frac{3}{2}$.

2/3 means 2 divided by 3, which is .667. $\frac{3}{2}$ means 3 divided by 2, which is 1.5. Now, .667 isn't the same as 1.5, is it?

All right. See if you can get this one.

Another way of writing V/W is:

(a) $\frac{V}{W}$ Turn to page 31

(b) W ÷ V Turn to page 27

Hold on there! I think you were a little careless on that one.

Both M ÷ K and M/K are correct ways of writing M divided by K.

Let's continue.

Does $2/3 = \frac{3}{2}$?

(a) Yes Turn to page 34

(b) No Turn to page 31

Good! Your answer was correct.

Keep it up.

The fraction $\frac{16}{21}$ really means:

(a) 1.31 Turn to page 38

(b) 21 divided by 16 Turn to page 27

(c) 16 divided by 21 Turn to page 29

Incorrect.

I don't think you read the problem very carefully.

It asked you to use the "÷" symbol.

Go back to page 33 and make another selection.

Turn to page 33.

No.

1.31 would be the answer you would get if you divided the denominator by the numerator. That is incorrect.

Go back to page 36 and see if there is a better selection.

Turn to page 36.

No. You seem to have forgotten what you have been practicing.

Reread page 20 and continue from there. Turn to page 20.

Whoa!

Your answer of bc does not even indicate division. It indicates multiplication. We'll get to multiplication soon, but for now let's concentrate on division.

See if you can work the problem on page 32 correctly. Turn to page 32.

No.

You got the divisor and the dividend switched around again.

See if you can get back on the right track with this one.

Does $\frac{4}{3} = 3 \div 4$?

(a) Yes Turn to page 39

(b) No Turn to page 36

Right!

Now, x · y means you should:

(a) divide x by y — Turn to page 43

(b) multiply x and y — Turn to page 60

No. Division was not the correct process in the last problem.

See if you can do better on this one.

Is this statement <u>true</u>? $(2 \cdot 7 = 3 \cdot 7)$

(a) Yes Turn to page 54

(b) No Turn to page 42

Very good! You have now looked at the basic symbols used for division. Let's take a look at multiplication.

There are four ways which are commonly used to denote multiplication. The multiplication of I and K may be written as I x K, I · K, IK, or (I)(K).

Also, you may see such forms as I(K), (I)K, or (I) · (K). But these merely derive from the basic four types. The x, ·, and ( ) all mean to multiply.

Turn to page 52

Try this problem.

6 x 3 = ?

(a) 3 Turn to page 51

(b) 18 Turn to page 47

(c) 2 Turn to page 54

No. Your answer was incorrect.

What have we been talking about these last few pages? Whenever you see a "·," you should always multiply the numbers on both sides.

Now, $12 \cdot 4 = ?$

(a) 3	Turn to page 43
(b) 16	Turn to page 48
(c) 48	Turn to page 42

Fine! Your answer was correct.

See if you can get this one.

Does $m \times n = m \cdot n$?

(a) Yes Turn to page 49

(b) No Turn to page 54

What? You must have added 12 and 4. The symbol for addition is "+". There was no "+" in the last problem.

Better try again.

Turn to page 46.

Very good! You said "·" and "x" give the same result, which they do.

Now, b · c means you should:

(a) multiply b and c Turn to page 60

(b) divide b by c Turn to page 50

(c) add b and c Turn to page 46

No. Your answer was incorrect.

What have we been talking about these last few pages? Whenever you see a "·," you should always multiply the numbers on both sides.

Now, 12 · 4 = ?

(a)	3	Turn to page 43
(b)	16	Turn to page 48
(c)	48	Turn to page 42

You said 6 x 3 = 3. Come now! 6 x 3 means you are supposed to <u>multiply</u> 6 and 3.

Go back to page 45 and multiply this time.

Turn to page 45.

O.K!!

Let's see if you can work some more problems.

Does 4 · 2 mean the same as 4 x 2?

(a) Yes Turn to page 49

(b) No Turn to page 55

No. You're making this material much too difficult.

I don't think you are trying hard enough.

Turn to page 44 and read <u>carefully</u>. Then continue from there.

No. You still aren't getting the idea.

There is only one thing to remember here. Both "·" and "x" mean to multiply. That's all there is to it.

Now, what does a x b mean?

(a) add a and b Turn to page 53

(b) multiply a and b Turn to page 47

Incorrect. Let's review it again.

The symbols "·" and "x" mean to multiply. So,

$4 \cdot 2 = 8$ and $4 \times 2 = 8$.

Therefore, $4 \cdot 2 = 4 \times 2$ is a true statement.

Now turn to page 45.

No. You did not notice the parentheses. They mean to multiply. You should have said (5)(4) = 20. All you were supposed to do was multiply 5 and 4.

Now, (2)(7) = ?

(a) 9 Turn to page 61

(b) 14 Turn to page 64

No.

You still are missing the idea. "·," "x," and " ( )"
all mean the same thing!!

Now, is M(N) = (M)(N)?

(a) Yes Turn to page 62

(b) No Turn to page 66

Wrong.

Let's review what we said some time ago. The following ways of expressing multiplication are all the same:

$$M \times N = M \cdot N = MN = M(N) = (M)(N) = (M) \cdot (N).$$

It doesn't matter which one you use. Use which ever one you like. But notice they are equivalent.

Turn to page 65 and continue.

You said 6(3) = 3. NO!

It is true that 6 - 3 = 3. However, the last problem did not tell you to subtract.

See if you can make a better choice this time. Turn to page 64.

Very good!

Keep it up.

Does XY = X(Y)?

(a) Yes Turn to page 63

(b) No Turn to page 58

No. You <u>did</u> <u>not</u> multiply. You should have multiplied.

Try this problem.

True or False: $2(5) = 3 \cdot 5$

(a) True — Turn to page 57

(b) False — Turn to page 64

Very good!

Now, does $4a = 4(a)$?

(a) Yes Turn to page 63

(b) No Turn to page 57

Excellent!

Try this one.

(5)(4) = ?

(a) 1 Turn to page 56

(b) 9 Turn to page 67

(c) 20 Turn to page 71

Good!

14 was correct.

Let's see if you can do another.

6(3) = ?

(a) 3 Turn to page 59

(b) 18 Turn to page 71

(c) 2 Turn to page 61

O.K.

See if you can get back on the track with this one.

Does (4)(3) = 4 x 3?

(a) Yes Turn to page 62

(b) No Turn to page 57

No. You're just not trying hard enough. This is really a very easy idea if you concentrate.

Turn to page 58 and continue.

No.

You did not notice the parentheses. They mean to multiply. You should have said (5)(4) = 20. All you were supposed to do was multiply 5 and 4.

Now, (2)(7) = ?

(a) 9 Turn to page 61

(b) 14 Turn to page 64

Let's see if you understand the idea we just discussed.

Does $49 = 4 \cdot 9$?

(a) Yes Turn to page 76

(b) No Turn to page 74

Incorrect.

The last problem illustrates the commutative law for multiplication. The law states that the order in which you multiply numbers doesn't matter. You will still get the same result.

For example, $3 \times 2 = 2 \times 3 = 6$

or $5 \cdot 6 = 6 \cdot 5 = 30$

Now turn to page 77.

Now, see if you can apply what you just read.

Is $2 \cdot 1$ the same as 21?

(a) Yes Turn to page 75

(b) No Turn to page 72

Very good!

At this time, let's discuss a very important concept. We have said that XY means to multiply X and Y. This is perfectly correct when using <u>letters</u>. However, you cannot use this method with numbers. For example,

$$53 \neq 5 \cdot 3.$$

Be careful not to make the mistake of saying 53 and $5 \cdot 3$ are the same. Whenever you multiply two or more <u>numbers</u> together, you must put some sort of multiplication sign between them.

Now turn to page 68.

Correct!

See if you can do this one.

Can you write 5(2) as 52?

(a) Yes Turn to page 75

(b) No Turn to page 74

Correct!

Now, does (5)(3) = 3(5)?

(a) Yes Turn to page 83

(b) No Turn to page 69

Fine!

Try this one.

True or False:

(2)(4) = (4)(2).

(a) True Turn to page 83

(b) False Turn to page 69

Incorrect.

I think you'd better reread the explanation.

Turn to page 71.

No.

You must not understand the "·" symbol. $4 \cdot 9 = 36$. The dot simply means to multiply. If you know this, it is clear that $49 \neq 4 \cdot 9$, since $49 \neq 36$.

Remembering that "·" means multiply, turn to page 70 and continue.

Turn to page 70.

See if you can apply what you just read to this problem.

Does $4 \cdot 7 = 7 \cdot 4$?

(a) Yes Turn to page 73

(b) No Turn to page 69

Incorrect.

The last problem illustrates the commutative law. Statements like ab = ba and MI = NM are true because the result is NOT determined by the order of multiplication.

Turn to page 84.

Very good! You have successfully mastered the ideas of this Unit. Let's review what you have learned.

1. You learned the proper use of "=" and "≠."

2. You learned that "/," "÷," and "-" all can be used to designate division.

3. You learned that "x," "·," and "( )" can be used to designate multiplication.

Now see your teacher for a test over this Unit.

Very good!

Now, does MN = NM?

(a) Yes Turn to page 79

(b) No Turn to page 78

O.K!

See if you can work this one.

True or False: $ab \neq ba$

(a) True Turn to page 78

(b) False Turn to page 79

No. You are missing the idea.

Turn to page 69 and continue from there.

Correct!

The last problem you worked illustrates the commutative law for multiplication. It states that the order in which you multiply numbers does not matter. If you are interested to see more about this idea, you can take Unit 16, which deals with the commutative law and its applications.

Turn to page 81.

Now try this one.

Does (2)(3) = (3)(4)?

(a) Yes Turn to page 82

(b) No Turn to page 80

TEST QUESTIONS

UNIT 1 - SYMBOLS

1. The statement X = 5 means that

   (a) X and 5 are not equal

   (b) X and 5 are equal

   (c) you should add X and 5

2. The statement $8 \neq 7$ is

   (a) True

   (b) False

3. Which of the following is <u>not</u> a way of expressing "6 divided by 3"?

   (a) $6 \div 3$

   (b) 6/3

   (c) (6)(3)

4. The statement c + d means

   (a) c divided by d

   (b) c times d

   (c) c is equal to d

5. If M is equal to N, you could express this as

   (a) M/N

   (b) $M \neq N$

   (c) M = N

6. The quantities a x b, a(b) and a.b all mean the same thing

   (a) True

   (b) False

7. The quantity of 6 x 3 is equal to

   (a) 3

   (b) 18

   (c) 9

8. The quantity xy means that

   (a) x should be multiplied by y

   (b) x and y should be added together

   (c) $x \neq y$

9. Does $4/5 = 4 \div 5$?

   (a) Yes

   (b) No

10. If you know that $K \neq 7$, you know that

    (a) $7 \neq 7$

    (b) K could be 7

    (c) K could be 15

11. The statement $\frac{12}{4} = 3$ is

    (a) Correct

    (b) Incorrect

12. The expression a(b) means the same as

    (a) a/b

    (b) $a \cdot b$

    (c) a + b

13. The quantity (3)(2) is equal to

    (a) 1

    (b) 5

    (c) 6

14. How would you write "3 is not equal to 5"?

    (a) $3 = 5$

    (b) $3 \neq 5$

    (c) 3(5)

15. Which of the following does not indicate division?

    (a) a/5

    (b) 32 ÷ 12

    (c) 14·4

16. Does X x Y = X·Y?

    (a) Yes

    (b) No

17. What is the value of 8 ÷ 2?

    (a) 16

    (b) 6

    (c) 4

18. The statement 2(5) = (3).5 is

    (a) True

    (b) False

19. Can you write 7(3) = 73?

    (a) Yes

    (b) No

20. The value of 10/5 is

(a) 2

(b) 5

(c) 50

21. Does $\frac{6}{5}$ = 5/6?

(a) Yes

(b) No

22. The value of (4)(2) is

(a) 2

(b) 6

(c) 8

23. How can you write "M divided by N"?

(a) $\frac{M}{N}$

(b) M x N

(c) M(N)

24. The value of 9/3 is

(a) 12

(b) 6

(c) 3

25. The quantities a(b), (a)(b), a·b all mean to divide a by b.

(a) True

(b) False

Answer Sheet - Unit 1

Objective	Question Number	Answer
1	1	b
1	2	a
2	3	c
2	4	a
1	5	c
3	6	a
3	7	b
3	8	a
1, 2	9	a
1	10	c
1, 2	11	a
3	12	b
3	13	c
1	14	b
2	15	c
1, 3	16	a
2	17	c
1, 3	18	b
1, 3	19	b
2	20	a
1, 2	21	b
3	22	c
3	23	a
2	24	c
3	25	b

Objectives	Questions
1	1, 2, 5, 9, 10, 11, 14, 16, 18, 19, 21
2	3, 4, 9, 11, 15, 17, 20, 21, 23, 24
3	6, 7, 8, 12, 13, 16, 18, 19, 22, 25

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TITLE

Occupational Mathematics - SYMBOLS

PERSONAL AUTHOR(S)

Rahmlow, Harold; Osthellar, Karl; Potratz, Clarence; Winchell, L.; Snoey, Arthur

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ABSTRACT

One book of a 21-book series of programmed instruction materials designed to help pupils acquire mathematics capabilities most useful in sub-professional level occupations. Other programmed books in the series are:

Representing Numbers by Letters
Equivalent Forms
Ratios and Fractions
Addition of Fractions
Subtraction of Fractions
Multiplication of Fractions
Division of Fractions
Concepts of Decimals and Fractions
Addition and Subtraction of Decimals
Multiplication of Decimals
Division of Decimals
Conversion of Fractions into Decimals
Equivalent Forms of A = BC
Solutions of A = BC
Percentage
Commutative Law
Reciprocals
Scientific Notation
Proportions
Concepts of Number Bases